REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Office Action dated October 24, 2005. In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

Claims 1-84 are under consideration in this application. Claims 3-4, 13-14, 35-36, 42, 45-46, 55-56, 77-78, and 84 are being cancelled without prejudice or disclaimer. Claims 1-2, 5-6, 9-12, 15-16, 23-30, 37-39, 43-44, 47-48, 51-54, 57-58, 65-72, and 79-81 are being amended, as set forth in the above marked-up presentation of the claim amendments, in order to more particularly define and distinctly claim Applicants' invention.

The claims are being amended to correct formal errors and/or to better disclose or describe the features of the present invention as claimed. All the amendments to the claims are supported by the specification. Applicants hereby submit that no new matter is being introduced into the application through the submission of this response.

Prior Art Rejections

Under 35 U.S.C. § 103(a), (1) Claims 1-2, 5-6, 9-12, 23-24, 43-44, 47-48, 51-54 and 65-66 were rejected as being unpatentable over US Patent No. 5,392,385 to Evangelisti et al. (hereinafter "Evangelisti") in view of US Patent No. 6,005,580 to Donovan (hereinafter "Donovan"); (2) Claims 3-4, 13-14, 45-46 and 55-56 were rejected as being unpatentable over Evangelisti, in view of Donovan, and further in view of US Patent No. 5,287,438 to Kelleher (hereinafter "Kelleher"); (3) Claims 7-8 and 49-50 were rejected as being unpatentable over Evangelisti, in view of Donovan, and further in view of US Patent No. 5,278,949 to Thayer (hereinafter "Thayer"); (4) Claims 21-22 and 63-64 were rejected as being unpatentable over Evangelisti, in view of Donovan, and further in view of US Patent No. 5,841,439 to Pose et al. (hereinafter "Pose"); (5) Claims 25-42 and 67-84 were rejected as being unpatentable over Evangelisti, in view of Donovan, and further in view of Japanese Laid-Open No. 07-105390 to Ikumi et al. (hereinafter "Ikumi"). Lastly, the prior art reference of Dickson et al. (4,873,515), Kumazaki et al. (5,325,474), Goyins et al. (5,461,703), Steiner

et al. (5,668,940), Diehl (5,673,379), Dye (5,684,941), Kuchkuda et al. (5,872,902), Lee et al. (5,903,279), McNamara et al. (6,329,977) and Thrasher (6,791,547) were cited as being pertinent to the present application. These rejections have been carefully considered, but are most respectfully traversed.

The polygon drawing apparatus of the invention, as now recited in claim 1, draws a polygon by performing intensity processing on a polygon to be drawn using an anti-aliasing method based on an intensity value I (I0L, ddIL, I0R, ddIR) generated by an intensity value generating device 1 (e.g., Fig. 10). The intensity value generating device 1 comprises: an edge calculating device which calculates line intersection data associated with an intersecting portion between each of edges of the polygon to be drawn, for a given one scan line N, using vertex coordinates (XA, YA), (XB, YB) and (XC, YC) of the polygon to be drawn, the line intersection data including a first pair of outside intersection and inside intersection that represent intersecting positions between said given one scan line N and one of the edges that is located on an upstream side as viewed in a scanning direction, a second pair of outside intersection and inside intersection that represent intersection positions between said given one scan line and one of the edges that is located on a downstream side as viewed in the scanning direction, an increasing rate at which an intensity value increases from the outside intersection to the inside intersection of said first pair, and a decreasing rate at which the intensity value decreases from the inside intersection to the outside intersection of said second pair, wherein the line intersection data is determined based on trajectories A-B, B-C, C-A obtained by dragging a diamond-like box between vertices A, B, C of the polygon to be drawn, said diamond-like box having diagonal dimensions in two coordinate axis directions X, Y and each of the diagonal dimensions being equal to a grid width + 0.5 (Fig. 5; [0098]; e.g., cancelled claim 3); and a scan line processing device 2 (e.g., Fig. 15B) which calculates with respect to said given one scan line N the intensity value I to be given to each portion of the polygon in the scanning direction, based on the line intersection data calculated for said given one scan line by said edge calculating device ("*The intensity value to be given to each portion of the polygon in the scanning direction with respect to each scan line is sequentially calculated based on the line intersection data obtained for each scan line.*" Abstract). The edge calculating device 1 and the scan line processing device 2 operate ***alternately*** during processing for said given one scan line to draw the polygon ([0097]; "*the controller 121 starts processing for one scan line when receiving a START signal from a circuit in the previous stage, and generates an END signal to the previous-stage circuit when Xp exceeds XRe.*" [0133]).

The invention applies the anti-aliasing method (line 32, page 1 to line 33, page 2), as now set forth in independent claims 1, 9-11, 23-30, 37-39, 43, 51-53, 65-72, and 79-81 for drawing smoothly the edge portions of a polygon. The invention determines the intensity values on each edge of a triangle (Figs. 5 and 6 of the specification) rather than the intensity values of all pixels inside the triangle as in the prior art. In addition, the invention determines the intensity value on each edge of a triangle relative to two reference points, such as XRi, XRe in Figs. 5-6 or XRir (=1), XRer (=0) in Figs. 8A-8B (p. 30, lines 10-16), rather than one base point. Such a "pair" reference feature of the present invention is inherent in the anti-aliasing method, which assumes each line to be drawn having certain width, as the first pair or the second pair intersection positions recited in claim 1. Moreover, the scan line processing of the invention calculates an intensity value to be given to each portion of a polygon in a scanning direction <u>with respect to each scan line</u>, based on line intersection data (XLe, XLi, XRi, XRe) obtained for each scan line by an edge calculating device. A scan line is determined according to a Y coordinate value Y_N that is output from an edge coordinate calculating circuit 12 (FIG. 12) in the edge calculating circuit 1 (p. 32, lines 24-33). The Y coordinate value Y_N is supplied to a controller 13, and is also supplied, as one of values constituting line intersection data, from the edge calculating circuit 1 to the horizontal line processing circuit 2 (shown by the arrow extending from the circuit 1 to the circuit 2 in FIG. 4). Based on the line intersection data including the Y coordinate value Y_N supplied from the edge calculating circuit 1, the horizontal line processing circuit 2 starts processing for calculating intensity values in respect of one scan line (P. 36, line 12+). When the processing on one scan line is performed, therefore, the edge calculating circuit 1 and the horizontal line processing circuit 2 alternately operate. In other word, unless line intersection data for one scan line is supplied from the edge calculating circuit 1, the horizontal line processing circuit 2 cannot carry out the edge calculation for the one scan line. The alternate feature of this invention is thus derived from the original disclosure of this application as a whole.

The present invention, as recited in all independent claims, calculates line intersection data associated with an intersecting portion between each of edges of the polygon (maybe drawn by combining a plurality of triangles, e.g., claim 25) to be drawn, for a given one scan line, using vertex coordinates of the polygon/triangles to be drawn. As such, the intensity value calculation processing is performed ***alternately*** with the line intersection data calculation processing. This makes it possible to realize the higher speed drawing processing which cannot be achieved by the cited references.

Applicants respectfully contend that none of the cited references teaches or suggest (1) that "the edge calculating device 1 and the scan line processing device 2 operate ***alternately*** during processing for said given one scan line to draw the polygon," and (2) that "the line intersection data, which is calculated by the edge calculating device, being determined based on trajectories obtained by dragging a diamond-like box between vertices of a polygon to be drawn, wherein the diamond-like box between vertices of a polygon to be drawn, wherein the diamond-like box between vertices of a polygon to be drawn, wherein the diamond-like box has diagonal dimensions in two coordinate axis directions, and each of the diagonal dimensions is equal to a grid width" according to the invention.

Regarding the feature (1), in contrast, Evangelisti first writes pixel values of a triangle in a frame buffer, reads out the stored triangle pixel values from the buffer, and thereafter performs anti-aliasing processing on the readout pixel values (col. 8, line 68 to col. 9, line 3; col. 9, lines 39-55). To this end, all the pixel values within the triangle are first calculated. Then, these pixel values are written into the frame buffer from which all the pixel values within the triangle are subsequently read out for performing anti-aliasing processing thereon. As such, the pixel value calculation processing is ***totally completed before*** the anti-aliasing processing in Evangelisti, rather than alternating between the two processing for each scan line as the invention.

Donovan draws a selected polygon as an output image in a frame buffer (step 240 in FIG. 2; col. 5, line 30; cols. 13-14), reads out the output image drawn in the frame buffer, subjects the output image to a filtering processing, and then performs an anti-aliasing processing (step 250 in FIG. 2, and col. 5, line 50). In the anti-aliasing processing, intersection points between a scan line and edges of the already drawn polygon are calculated, a texture coordinate and a pixel coordinate for each intersection point are identified, and a filtering operation is performed to determine corrected pixel colors. Thus, Donovan also performs the drawing processing for a polygon output image and the anti-aliasing processing ***separately from each other***.

As pointed out in the prior response, Evangelisti and Donovan require data writing processing into and data reading processing from the frame buffer because all the pixel values or the entire image of a polygon once written into the frame buffer must be read out therefrom for the anti-aliasing processing, and the writing processing and the reading processing are time-consuming, making it difficult to realize high-speed polygon drawing.

Ikumi first writes a pixel or an image once into a frame buffer and then reads out the pixel or the image from the buffer and ***then*** performing anti-aliasing processing such that it

does not perform the anti-aliasing processing and the polygon drawing processing alternately.

The other cited references simply fail to compensate for the same deficiencies.

Regarding the (2) feature, the invention makes it easy to calculate coordinate values of outside and inside intersections. Preferably, coordinate values of outside and inside intersections are calculated by adding ±0.5 (half of a grid width) to a coordinate value of an intersection between a corresponding edge and a corresponding scan line. Increasing and decreasing rates of intensity value are determined based on the so-calculated coordinate values of outside and inside intersections. As such, calculation processing for line intersection data is extremely simplified, resulting in high-speed drawing.

Kelleher was relied upon by the examiner to teach the feature (2) which was recited in the original claim 13 as "calculating intersections using a diamond-like block". Kelleher merely provides 16 (4x4) regions in a single pixel and carries out a processing to determine whether each of 16 regions lies inside or outside of a polygon using a polygon edge descriptive function. Kelleher fails to disclose or suggest a technical concept of using "trajectories obtained by dragging a diamond-like box between vertices of a polygon to be drawn" in order to calculate line intersection data, wherein the diamond-like box has diagonal dimensions in two coordinate axis directions, and each of the diagonal dimensions is equal to a grid width.

In the present invention, a diamond-like box having diagonal dimensions, equal to a grid width, in two coordinate axis directions is selected as one to be dragged. As a result, the calculation of coordinate values of outside and inside edges can be made extremely easy, and the increasing and decreasing rates of intensity rates of intensity value can also be extremely easily calculated. Such advantageous effects cannot be achieved by Kelleher.

The other cited references simply fail to compensate for the same deficiencies. For example, Evangelisti only draws a triangle with thick edges (e.g., Fig. 4), but does not use any "trajectories obtained by dragging a diamond-like box between vertices of a polygon to be drawn."

To sum up, (1) the alternated "anti-aliasing processing" and "drawing processing" and (2) "line intersection data being determined based on trajectories A-B, B-C, C-A obtained by dragging a diamond-like box between vertices A, B, C of the polygon to be drawn, said diamond-like box having diagonal dimensions in two coordinate axis directions X, Y and each of the diagonal dimensions being equal to a grid width + 0.5" as now recited in

claims 1, 9-11, 23-30, 37-39, 43, 51-53, 65-72, and 79-81 are not taught or suggested by any of the cited prior art references.

Applicants contend that none of the cited references or their combinations teaches or suggests each and every feature of the present invention as recited in independent claims 1, 9-11, 23-30, 37-39, 43, 51-53, 65-72, and 79-81. As such, the present invention as now claimed is distinguishable and thereby allowable over the rejections raised in the Office Action. The withdrawal of the outstanding prior art rejections is in order, and is respectfully solicited.

Conclusion

In view of all the above, clear and distinct differences as discussed exist between the present invention as now claimed and the prior art reference upon which the rejections in the Office Action rely, Applicants respectfully contend that the prior art references cannot anticipate the present invention or render the present invention obvious. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicants' undersigned representative at the address and telephone number indicated below.

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